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A METHOD FOR THE DETERMINATION OF THE SPECIFIC GRAVITY OF WHEAT AND OTHER CEREALS.

BY

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A METHOD FOR THE DETERMINATION OF THE SPECIFIC GRAVITY OF WHEAT AND OTHER CEREALS.[1]

INTRODUCTION.

In buying and selling wheat great importance is placed on the density of the wheat kernels, the various degrees of which affect to a considerable extent the commercial grading and the price that the wheat will command.

Believing that the specific gravity of wheat might in a measure indicate milling quality, a study of the relationship of specific gravity to milling yield was undertaken. Of a large number of liquids tried in these experiments for specific-gravity determinations, toluene was found to possess more nearly the required properties. Toluene (known commercially as toluol), $C_6H_5CH_3$, possesses the desired properties in that it has (1) relatively low specific gravity; (2) a low surface tension, enabling it to flow smoothly in thin sheets; (3) a fairly high boiling point, insuring not too high volatility; (4) physical constants, including specific gravity, viscosity, etc., that will not change materially on exposure to the atmosphere; and (5) a nonsolvent action on the constituents of the kernel. It is likewise immiscible with water and practically nonexplosive. Toluene was therefore employed with the results set forth in the following pages.

By employing a liquid medium of this character it is possible to use a specific-gravity bottle, or picnometer. A picnometer of the size and style shown in figure 1 was found to be the most satisfactory. The ground-in thermometer is of decided advantage in making all determinations at the same temperature (20° centigrade). The capillary side tube serves as a convenient overflow for the excess toluene when the bottle is filled at temperatures below 20° C. The small cap is used to cover the side tube when the thermometer registers 20° C. and to hold that which passes up this tube as the contents of the bottle reach the room temperature.

[1] Since the preparation of this paper one of the writers, Mr. C. H. Bailey, has accepted a position at the University of Minnesota and is now in charge of the cereal and flour laboratory of the Minnesota Agricultural Experiment Station.—J. W. T. Duvel, *Crop Technologist in Charge of Grain Standardization Investigations.*

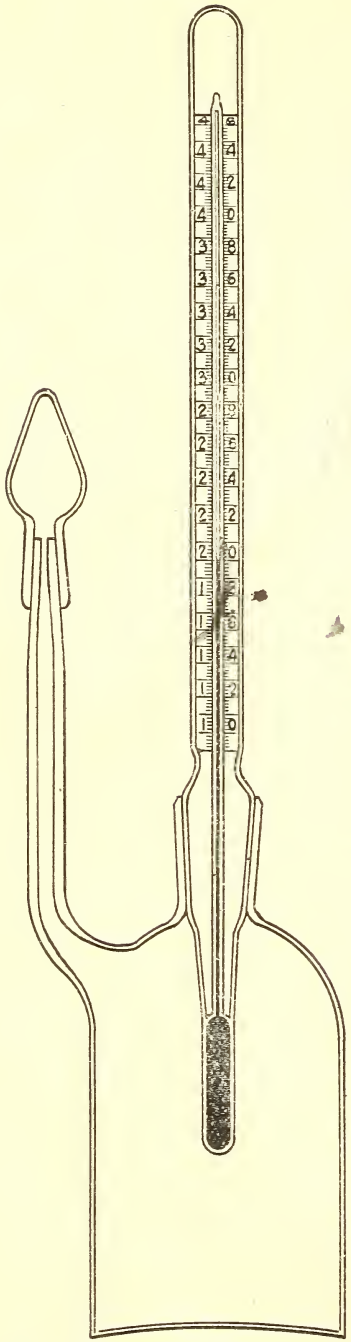

FIG. 1.—Picnometer used in specific-gravity determinations.

[Cir. 99]

HOW TO MAKE THE SPECIFIC-GRAVITY TEST.

In addition to the picnometer, or specific-gravity bottle, used in making the determinations, it is necessary to have a good analytical balance and an aspirator, or filter pump. If it is desired to purify the toluene used in previous tests, gas burners or some other form of heating appliance and condensers will be required in addition to the apparatus mentioned.

After the capacity of the picnometer has been ascertained by weighing it when empty and likewise when filled with distilled water at 20° C., the specific gravity of the toluene is determined in the usual way by comparing the weight of toluene which the bottle holds with the weight of the distilled water at the same temperature:

Weight of water : weight of toluene :: 1.0000 : x,

x equaling the specific gravity of the toluene. Each lot of toluene must be tested, as there may be a slight variation in its specific gravity.

Ten grams of the cleaned wheat sample (the exact weight being recorded) are placed in the picnometer, and a sufficient quantity of cooled toluene is added to a little more than cover the wheat. The cap is placed on the capillary tube, the neck of the picnometer connected with the filter pump, or aspirator, and the air gradually exhausted. This promotes the escape of the air from the mass and particularly that held under the surface hairs and in the creases of the kernels. When the air bubbles cease to be given off, the vacuum is released for a moment and the bottle is then reexhausted. When no more bubbles rise, the picnometer is

disconnected from the pump and completely filled with toluene cooled to about 18° C. The thermometer is then placed tightly in the neck of the bottle and the temperature of bottle and contents allowed to rise gradually to exactly 20° C. The last drop on the end of the capillary tube is removed with a piece of filter paper, the overflow cap set firmly in place, and the picnometer and contents weighed on a good analytical balance.

The specific gravity of the sample is calculated according to the following formula:

$$\text{Specific gravity of the wheat} = \frac{\text{Specific gravity of the toluene} \times \text{weight of the wheat.}}{\text{Weight of the toluene displaced by the wheat.}}$$

For example, if the weight of the picnometer containing toluene and the 10 grams of wheat is 87.2697 grams and the weight of the picnometer containing toluene alone is 83.4461 grams, then by subtracting the latter figure from the former we have 3.8236 grams, and this subtracted from 10 gives 6.1764, which is the weight in grams of the toluene displaced by 10 grams of wheat. Substituting in the formula given above, we have $\frac{0.8667 \times 10}{6.1764} = 1.4032$, the specific gravity of the wheat.

ADVANTAGE OF USING TOLUENE.

Toluene has been found most satisfactory for specific-gravity determinations, there being little tendency for this substance to soak into the kernels, as is the case with water and alcohol. After standing several hours in toluene no appreciable change in the results of the test was found, showing that the toluene did not enter the kernels to any extent. Toluene apparently does not dissolve out any great amount of fats and oils from the kernels, as is evidenced by the fact that, if filtered after using, its specific gravity is found not to have changed materially. Commercial toluol, costing from 35 to 40 cents a pound, can be used instead of the more expensive chemically pure toluol. This commercial product has a specific gravity of about 0.8667 and will not change materially if kept in a cool place in a tight can or bottle.

Alcohol, when tried, exhibited a tendency to soak into the kernels when suction was applied. Alcohol also changes in its specific gravity, through evaporation of alcohol and the consequent increase in the relative proportion of water, to an extent that renders the results of little value. On the other hand, the results obtained without applying suction when toluene was used were not correct, as was evidenced by the way in which air bubbles were given off when the bottle was connected to the aspirator.

NECESSITY FOR EXHAUSTING THE AIR.

That it is necessary to exhaust the air from the picnometer containing the wheat covered with toluene in order to free the wheat from mechanically held air is shown in Table I, in which are given the results of specific-gravity determinations made with and without the use of the aspirator. This table further shows that the volume of air so held is not the same in all cases. The specific gravity of a number of samples determined without aspiration will therefore not necessarily run parallel to the true specific gravity of the same samples.

TABLE I.—*Specific-gravity determinations made with and without the use of the aspirator.*

No. of sample.	Specific gravity.			Volume of air removed by aspirator.
	Without aspirator.	With aspirator.	Difference.	
				C. c.
576	1.4055	1.4242	0.0187	0.120
577	1.4067	1.4299	.0224	.129
578	1.3945	1.4235	.0290	.165
589	1.3216	1.3798	.0582	.335
596	1.4246	1.4427	.0181	.110
607	1.3710	1.4306	.0596	.258
611	1.4199	1.4341	.0142	.108
612	1.3964	1.4175	.0211	.101
621	1.3920	1.4398	.0478	.240
Maximum	1.4246	1.4427	.0596	.335
Minimum	1.3216	1.3798	.0142	.101
Average	1.3925	1.4247	.0321	.174

UNIFORMITY IN DUPLICATE TESTS.

Table II shows the results of duplicate specific-gravity determinations of 13 wheat samples, representing both hard and soft wheats. The maximum variation from the average of the two determinations amounted to 0.0039, the average variation being 0.0009. Considering the difficulty of securing two samples of 10 grams each which are exactly alike from any given lot of wheat, this variation is very slight and indicates a small unavoidable error in sampling rather than an inaccuracy in the test.

TABLE II.—*Specific-gravity determinations showing uniformity in results of duplicate tests.*

No. of sample.	Duplicate determinations.			Variation from average.
	First.	Second.	Average.	
596	1.4418	1.4436	1.4427	0.0009
621	1.4393	1.4402	1.4398	.0005
611	1.4349	1.4333	1.4341	.0008
607	1.4297	1.4315	1.4306	.0009
577	1.4274	1.4307	1.4291	.0016
576	1.4247	1.4236	1.4242	.0006
612	1.4169	1.4181	1.4175	.0006
351	1.4133	1.4133	1.4133	.0000
353	1.4134	1.4106	1.4120	.0014
352	1.3986	1.3978	1.3982	.0004
590	1.3922	1.3856	1.3895	.0039
589	1.3804	1.3789	1.3798	.0008
243	1.3616	1.3615	1.3616	.0001

Maximum variation from average, 0.0039. Average variation from average, 0.0009.

CONCLUSIONS.

The method described in this paper for determining the specific gravity of wheat gives very uniform results and is entirely satisfactory.

Since this method was devised the correlation of specific gravity with the quality of wheat has been undertaken. It appears very probable from the work so far that this test, with others, will prove of value in indicating kernel structure, milling quality, and flour yield of wheat.

Approved:

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *May 31, 1912.*

[Cir. 99]

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